

What is claimed is:

1. A hybrid circuit substrate with optical and electrical interconnects comprising:
  - 5 a base substrate section having an interconnect layer formed on an insulating substrate by a printed circuit process;
  - a micro interconnect circuit section having a micro electrical interconnect layer which is finer than the interconnect layer of the base substrate section, formed on an insulating resin layer by a semiconductor process; and
  - 10 an optical interconnect circuit section adapted to transfer and/or receive an optical signal and provided with an optical wave-guide having an input section and an output section of a optical signal at opposite ends thereof; and an optical element composed of a light emitting device with a light emitting section thereof facing the input section and a photo detecting device with a photo detecting section thereof facing the output section; wherein
  - 15 said micro interconnect circuit section and said optical interconnect circuit section are mounted on said base substrate section so as to transmit an electrical signal and an optical signal.
2. The hybrid circuit substrate according to claim 1, wherein said base substrate section comprises said insulating substrate having as a constituent thereof one of a ceramic material, a hybrid material of a ceramic material and an organic material, and an organic material.
3. The hybrid circuit substrate according to claim 1, wherein said optical wave-guide is formed by of one of a photoconductive resin material, a fluorine-containing

photoconductive resin material and a polymer material made of a compound of said photoconductive resin material and said fluorine-containing photoconductive resin material.

- 5 4. The hybrid circuit substrate according to claim 1,  
wherein:

said micro interconnect circuit section is mounted on a surface of said base substrate section by having a first surface as a mounting surface; and

- 10 power is supplied to said optical element from said base substrate section via said micro interconnect circuit section, when said optical interconnect circuit section is mounted on a second surface of said micro interconnect circuit section by having a first surface as a mounting surface.

- 15 5. The hybrid circuit substrate according to claim 4 further comprising a connecting terminal connected via said micro interconnect circuit section and a via hole to a surface of said optical interconnect circuit section, for mounting and  
20 electrically interconnecting electronic components on a second surface of said optical interconnect circuit section.

6. The hybrid circuit substrate according to claim 1,  
wherein:

- 25 said optical interconnect circuit section is mounted on a surface of said base substrate section by having said first surface as a mounting surface; and

- 30 said micro interconnect circuit section is mounted on a second surface of said optical interconnect circuit section by having said first surface as a mounting surface.

7. The hybrid circuit substrate according to claim 6, wherein electronic components are mounted and electrically interconnected on a second surface of said micro interconnect circuit section.

5

8. The hybrid circuit substrate according to claim 1, wherein:

10        said optical interconnect circuit section is mounted on a first surface of said micro interconnect circuit section by being coated by an insulation layer; and

      said optical interconnect circuit section is packed upon having said micro interconnect circuit section mounted on a surface of said base substrate and having said insulation layer as a mounting surface

15

9. A hybrid circuit substrate manufacturing method for manufacturing a hybrid circuit substrate with optical and electrical interconnects, comprising the steps of:

20        manufacturing a base substrate section having an interconnect layer formed on an insulating substrate by a printed circuit process;

25        manufacturing a micro interconnect circuit section having a micro electrical interconnect layer which is finer than the interconnect layer of the base substrate section, formed on an insulating resin layer by a semiconductor process; and

30        manufacturing an optical interconnect circuit section adapted to transfer and/or receive an optical signal and provided with an optical wave-guide having an input section and an output section of a optical signal at opposite ends thereof; and an optical element composed of a light emitting device with a light emitting section thereof facing the input

section and a photo detecting device with a photo detecting section thereof facing the output section;

mounting said micro interconnect circuit section and said optical interconnect circuit section on said base substrate section; and

manufacturing a hybrid circuit substrate having transmission channels for an electrical signal and an optical signal.

10 10. The hybrid circuit substrate manufacturing method according to claim 12, further comprising:

micro interconnect circuit section mounting step of mounting said micro interconnect circuit section on a surface of said base substrate section by having said first surface as a mounting surface; and

optical interconnect circuit section mounting step of mounting said optical interconnect circuit section on a second surface of said micro interconnect circuit section by having said first surface as a mounting surface; wherein

20 said micro interconnect circuit section and said optical interconnect circuit section are formed stacked on said base substrate section.

25 11. The hybrid circuit substrate manufacturing method according to claim 9, further comprising:

optical interconnect circuit section mounting step of mounting said optical interconnect circuit section on a surface of said base substrate section by having said first surface as a mounting surface; and

30 micro interconnect circuit section mounting step of mounting said micro interconnect circuit section on a second

surface of said optical interconnect circuit section by having said first surface as a mounting surface; wherein

5           said optical interconnect circuit section and said micro interconnect circuit section are formed stacked on said base substrate section.

12. The hybrid circuit substrate manufacturing method according to claim 9, further comprising the steps of:

10          forming an insulation resin layer on a release layer of a dummy substrate, wherein said dummy substrate includes one of a silicon substrate and a glass substrate having a release layer formed on a planarized surface thereof;

15          forming said micro interconnect circuit section by including at least one micro electric interconnect layer which is finer than a interconnect layer of said base circuit section, on said insulation resin layer by a semiconductor process; and

              releasing said micro interconnect circuit section from said dummy substrate via said release layer.

20         13. The hybrid circuit substrate manufacturing method according to claim 12, wherein said micro interconnect circuit section is manufactured on said dummy substrate so as to have a first surface constituting a mounting surface for a surface of said base substrate section as an upper layer.

25

30         14. The hybrid circuit substrate manufacturing method according to claim 12, wherein said step of releasing from said dummy substrate is performed after said micro interconnect circuit section is mounted on one of said base substrate section and a second surface of said optical interconnect circuit section.

15. The hybrid circuit substrate manufacturing method according to claim 9, further comprising the steps of:

forming said optical wave-guide on a release layer by packing a core material by means of a clad material, wherein  
5 said dummy substrate includes one of a silicon substrate and a glass substrate having a release layer formed on a planarized surface thereof; and

releasing from said dummy substrate via said release layer.

10

16. The hybrid circuit substrate manufacturing method according to claim 9, further comprising the steps of:

manufacturing said micro interconnect circuit section by steps of forming an insulation resin layer on a release layer of  
15 a dummy substrate, wherein said dummy substrate comprises one of a silicon substrate and a glass substrate having a release layer formed on a planarized surface thereof; and forming said micro interconnect circuit section by including at least one micro electric interconnect layer which is finer than a  
20 interconnect layer of said base circuit section, on said insulation resin layer by a semiconductor process;

manufacturing said optical interconnect circuit section by forming said optical wave-guide on said release layer by utilizing a dummy substrate comprising one of a silicon  
25 substrate and a glass substrate having a release layer formed on a planarized surface thereof;

joining said micro interconnect circuit section with said optical interconnect circuit section by having respective uppermost layers as joining surfaces and being hold by  
30 respective dummy substrates;

releasing said dummy substrates from one of said micro

interconnect circuit section and said optical interconnect circuit section via said releasing layer;

- mounting on a surface of said base substrate section by having said released surface of one of said micro interconnect circuit section and said optical interconnect circuit section as a mounting surface; and

- releasing said other dummy substrate from one of said micro interconnect circuit section and said optical interconnect circuit section being hold by said other dummy substrate via said releasing layer.

17. The hybrid circuit substrate manufacturing method according to claim 9, further comprising the steps of:

- manufacturing said micro interconnect circuit section by steps of: forming an insulation resin layer on a release layer of a dummy substrate, wherein said dummy substrate comprises one of a silicon substrate and a glass substrate having a release layer formed on a planarized surface thereof; and forming said micro interconnect circuit section by including at least one micro electric interconnect layer which is finer than a interconnect layer of said base circuit section, on said insulation resin layer by a semiconductor process;

- manufacturing said optical interconnect circuit section by forming said optical wave-guide on said release layer by utilizing a dummy substrate comprising one of a silicon substrate and a glass substrate having a release layer formed on a planarized surface thereof;

- joining said micro interconnect circuit section with said optical interconnect circuit section by having respective uppermost layers as joining surfaces and being hold by respective dummy substrates;

releasing said dummy substrate from said optical interconnect circuit section via said releasing layer and mounting an optical element on said released surface;

5 forming a connecting pad constituting a connecting terminal for electrically connecting an uppermost exposed layer of said micro interconnect circuit section with said base substrate section;

10 forming an insulation layer on said uppermost exposed layer of said micro interconnect circuit section so as to coat said exposed optical interconnect circuit section and said connecting pad;

polishing said insulation layer so as to expose said optical element and said connecting pad;

15 connecting and mounting on a surface of said base substrate section said connecting terminal and said optical element to said interconnection layer by having said insulation layer as a mounting surface; and

20 releasing said dummy substrate of said micro interconnect circuit section side via said releasing layer; wherein

said optical interconnect circuit section is mounted between said micro interconnect circuit section and said base substrate section.

25 18. A hybrid circuit module with optical and electrical interconnects comprising:

a base substrate section having an interconnect layer formed on an insulating substrate by a printed circuit process;

30 a micro interconnect circuit section having a micro electrical interconnect layer which is finer than the interconnect layer of the base substrate section, formed on an

- insulating resin layer by a semiconductor process; and  
an optical interconnect circuit section adapted to transfer  
and/or receive an optical signal and provided with an optical  
wave-guide having an input section and an output section of a  
5 optical signal at opposite ends thereof; and an optical element  
composed of a light emitting device with a light emitting  
section thereof facing the input section and a photo detecting  
device with a photo detecting section thereof facing the output  
section; and
- 10 electronic components mounted on a surface of one of  
said base substrate section, said micro interconnect circuit  
section and said optical interconnect circuit section, and  
electrically connected to one of said interconnect layer, said  
micro electric interconnect layer and said optical element;
- 15 wherein  
said micro interconnect circuit section and said optical  
interconnect circuit section are mounted on said base substrate  
section so as to transmit an electrical signal and an optical  
signal.
- 20 19. The hybrid circuit module according to claim 18,  
wherein:  
said optical interconnect circuit section and at least a  
pair of semiconductor chips as said electronic components  
25 electrically connected to said micro electric interconnect layer  
are mounted on said micro interconnect circuit section; and  
transfer of an information signal between said  
semiconductor chips are performed by optical transfer via said  
optical element and said optical wave-guide of said optical  
30 interconnect circuit section.

20. The hybrid circuit module according to claim 18, wherein said optical interconnect circuit section is interposed between said micro interconnect circuit section and said base substrate section.

5

21. A hybrid circuit module manufacturing method for manufacturing a hybrid circuit substrate with optical and electrical interconnects, comprising the steps of:

manufacturing a base substrate section having an  
10 interconnect layer formed on an insulating substrate by a printed circuit process;

manufacturing a micro interconnect circuit section having a micro electrical interconnect layer which is finer than the interconnect layer of the base substrate section, formed on  
15 an insulating resin layer by a semiconductor process; and

manufacturing an optical interconnect circuit section adapted to transfer and/or receive an optical signal and provided with an optical wave-guide having an input section and an output section of a optical signal at opposite ends  
20 thereof; and an optical element composed of a light emitting device with a light emitting section thereof facing the input section and a photo detecting device with a photo detecting section thereof facing the output section;

mounting said micro interconnect circuit section and said  
25 optical interconnect circuit section on said base substrate section; and

mounting an electronic component on a surface of one of said base substrate section, said micro interconnect circuit section and said optical interconnect circuit section; wherein

30 said hybrid circuit substrate comprises transfer channels for an optical signal and an electric signal for optically

transferring an information signal between said at least a pair of semiconductor chips mounted on said micro electric interconnect layer, via said optical element and said optical wave-guide.

5

22. The hybrid circuit module manufacturing method according to claim 21, further comprising the steps of:

10 forming an insulation resin layer on a release layer of a dummy substrate, wherein said dummy substrate includes one of a silicon substrate and a glass substrate having a release layer formed on a planarized surface thereof;

15 forming said micro interconnect circuit section by including at least one micro electric interconnect layer which is finer than a interconnect layer of said base circuit section, on said insulation resin layer by a semiconductor process; and

releasing said micro interconnect circuit section from said dummy substrate via said release layer.

23. The hybrid circuit module manufacturing method  
20 according to claim 21, further comprising the steps of:

25 forming said optical wave-guide on a release layer by packing a core material by means of a clad material, wherein said dummy substrate includes one of a silicon substrate and a glass substrate having a release layer formed on a planarized surface thereof; and

releasing from said dummy substrate via said release layer.

24. The hybrid circuit module manufacturing method  
30 according to claim 21, further comprising the steps of:

manufacturing said micro interconnect circuit section by

- steps of: forming an insulation resin layer on a release layer of a dummy substrate, wherein said dummy substrate comprises one of a silicon substrate and a glass substrate having a release layer formed on a planarized surface thereof; and forming said
- 5 micro interconnect circuit section by including at least one micro electric interconnect layer which is finer than a interconnect layer of said base circuit section, on said insulation resin layer by a semiconductor process;
- manufacturing said optical interconnect circuit section
- 10 by forming said optical wave-guide on said release layer by utilizing a dummy substrate comprising one of a silicon substrate and a glass substrate having a release layer formed on a planarized surface thereof;
- joining said micro interconnect circuit section with said
- 15 optical interconnect circuit section by having respective uppermost layers as joining surfaces and being hold by respective dummy substrates;
- releasing said dummy substrates from one of said micro interconnect circuit section and said optical interconnect circuit
- 20 section via said releasing layer;
- mounting on a surface of said base substrate section by having said released surface of one of said micro interconnect circuit section and said optical interconnect circuit section as a mounting surface; and
- 25 releasing said other dummy substrate from one of said micro interconnect circuit section and said optical interconnect circuit section being hold by said other dummy substrate via said releasing layer.
- 30 25. The hybrid circuit module manufacturing method according to claim 21, further comprising the steps of:

- manufacturing said micro interconnect circuit section by steps of: forming an insulation resin layer on a release layer of a dummy substrate, wherein said dummy substrate comprises one of a silicon substrate and a glass substrate having a release layer formed on a planarized surface thereof; and forming said micro interconnect circuit section by including at least one micro electric interconnect layer which is finer than a interconnect layer of said base circuit section, on said insulation resin layer by a semiconductor process;
- 10 manufacturing said optical interconnect circuit section by forming said optical wave-guide on said release layer by utilizing a dummy substrate comprising one of a silicon substrate and a glass substrate having a release layer formed on a planarized surface thereof;
- 15 joining said micro interconnect circuit section with said optical interconnect circuit section by having respective uppermost layers as joining surfaces and being hold by respective dummy substrates;
- 20 releasing said dummy substrate from said optical interconnect circuit section via said releasing layer and mounting an optical element on said released surface;
- 25 forming a connecting pad constituting a connecting terminal for electrically connecting an uppermost exposed layer of said micro interconnect circuit section with said base substrate section;
- 30 forming an insulation layer on said uppermost exposed layer of said micro interconnect circuit section so as to coat said exposed optical interconnect circuit section and said connecting pad;
- polishing said insulation layer so as to expose said optical element and said connecting pad;

connecting and mounting on a surface of said base substrate section said connecting terminal and said optical element to said interconnection layer by having said insulation layer as a mounting surface; and

5 releasing said dummy substrate of said micro interconnect circuit section side via said releasing layer; wherein

10 said optical interconnect circuit section is mounted between said micro interconnect circuit section and said base substrate section.